

Patent Claims

1. An electromechanical drive or sensor element having a layer structure, which comprises
- 5 - a plurality of piezoelectric ceramic layers (12a-f; 22a-d; 41a-f),
- an electrode layer (16a-e; 26a-d) which is arranged between two mutually facing surfaces of directly adjacent piezoelectric ceramic layers, and
- 10 - an electrical connector (18a,b; 28a,b; 58a,b) for making electrical contact with the electrode layer (16a-e; 26a-d),
- in which case the connector (18a,b; 28a,b; 58a,b) is likewise arranged and is passed out between the two mutually facing surfaces of the piezoelectric ceramic layers (12a-f; 22a-d; 41a-f).
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2. An electromechanical drive or sensor element having a layer structure,
- having a plurality of piezoelectric ceramic layers (12a-f; 22a-d; 41a-f),
- in which mutually facing surfaces of directly adjacent piezoelectric ceramic layers (12a-f; 22a-d; 41a-f) are metallized by application of a metal coating,
- 25 -- which are joined together by means of diffusion welding,
- so that an electrode layer (16a-e; 26a-d) is formed by the metallized surfaces,
- 30 --- with which contact can be made via an electrical connector (18a,b; 28a,b; 58a,b).
- 35 3. The drive or sensor element as claimed in one of claims 1 or 2, in which a groove (14a-d; 24a-d; 56a-f) is provided in at least one of the two mutually facing surfaces of the piezoelectric

ceramic layers (12a-f; 22a-d; 41a-f) and at least partially holds the electrical connector (18a,b; 28a,b; 58a,b).

- 5 4. The drive or sensor element as claimed in claim 3, in which the connector (18a,b; 28a,b; 58a,b) is a wire which extends beyond the surfaces of the piezoelectric ceramic layers (12a-f; 22a-d; 41a-f).
- 10 5. The drive or sensor element as claimed in one of claims 3 or 4 having at least three piezoelectric ceramic layers (12a-f; 22a-d; 41a-f) and at least two grooves (14a-d; 24a-d; 56a-f), in which these
- 15 grooves (14a-d; 24a-d; 56a-f) are arranged offset with respect to one another and with respect to a longitudinal axis (29) of the drive or sensor element.
- 20 6. The drive or sensor element as claimed in one of claims 4 or 5 having a connector (18a,b; 28a,b; 58a,b) which is in the form of a wire and is a wire having a rippled or zigzag structure.
- 25 7. The drive or sensor element as claimed in one of claims 1 to 6 having piezoelectric ceramic layers (12a-f; 22a-d; 41a-f) composed of PZT material.
- 30 8. The drive or sensor element as claimed in one of claims 1 to 7 having piezoelectric ceramic layers (12a-f; 22a-d; 41a-f) composed of $\text{PbMg}_{0.308}\text{Nb}_{0.617}\text{Ti}_{0.075}\text{O}_3$.
- 35 9. The drive or sensor element as claimed in one of claims 1 to 8 having piezoelectric ceramic layers (12a-f; 22a-d; 41a-f) composed of a material having a Curie temperature of more than 400°C, for example composed of $\text{Na}_{0.5}\text{Bi}_{4.5}\text{Ti}_4\text{O}_{15}$ or $\text{Bi}_3\text{TiNbO}_9$.

10. The drive or sensor element as claimed in one of claims 1 to 9 having electrode layers (16a-e; 26a-d) composed of a metallic material having a Curie temperature of more than 400°C.
11. The drive or sensor element as claimed in one of claims 1 to 10 having electrode layers (16a-e; 26a-d) composed of bismuth-titanate.
12. The drive or sensor element as claimed in one of claims 4 to 11 having connectors (18a,b; 28a,b; 58a,b) which are in the form of wires and are composed of a metallic material having high-temperature stability at more than 250°C.
13. The drive or sensor element as claimed in one of claims 4 to 11 having connectors (18a,b; 28a,b; 58a,b) which are in the form of wires and are composed of a material which contains silver and contains stainless steel, or of such a material which contains a nickel alloy.
14. A method for producing an electromechanical drive or sensor element having a layer structure, which comprises the following steps:
- production of ceramic layers (12a-f; 22a-d; 41a-f) composed of electrically active material using a method which is normal in ceramic technology, having desired dimensions and having a margin of 2-3 mm for each dimension taking account of the following mechanical machining;
 - grinding the ceramic layers (12a-f; 22a-d; 41a-f) until a predetermined thickness of, for example, 0.15 to 03 mm [sic] is reached;

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- cutting a groove (14a-d; 24a-d; 56a-f) in one face of the ceramic layers (12a-f; 22a-d; 41a-f) which is to be metallized;
 - in which case the depth of the groove (14a-d; 24a-d; 56a-f) must be no deeper than half the thickness of the ceramic layer (12a-f; 22a-d; 41a-f) under consideration;
 - coating at least one face of the ceramic layers (12a-f; 22a-d; 41a-f) with metal by applying a paste containing silver twice and subsequent heat treatment at a temperature of 800-820°C;
 - applying adhesive to the metallized surfaces of two ceramic layers (12a-f; 22a-d; 41a-f) using cellulose adhesive;
 - diffusion welding of the layers to which adhesive has been applied by heat treatment at a temperature of 780-800°C and single-axis compression at a pressure of 3-5 kg/cm² over a period of 3 hours and cooling to room temperature;
 - drawing in each case one connector wire (18a,b; 28a,b; 58a,b) into a groove (14a-d; 24a-d; 56a-f);
 - polarization of the drive or of the sensor element by the action of an electric field on the wires (18a,b; 28a,b; 58a,b) at high temperature;
 - connection of the same poles of the drive or of the sensor element;
 - checking of the desired parameters and piezo-electric characteristics of the drive or of the sensor element.
15. A level limit switch (70) having a drive and having a sensor element as claimed in one of claims 1 to 14.

16. The level limit switch (70) as claimed in claim 15, in which the sensor element is separated from the drive by a non-polarized ceramic layer (82d).

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17. An acceleration sensor (40) having a sensor element as claimed in one of claims 1 to 14.

1. A sensor element (40) comprising a sensor element (40) and a drive element (42) separated by a non-polarized ceramic layer (82d).
2. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element.
3. The sensor element (40) of claim 1, wherein the drive element (42) is a piezoelectric drive element.
4. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
5. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
6. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
7. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
8. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
9. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
10. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
11. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
12. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
13. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
14. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
15. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
16. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
17. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
18. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
19. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.
20. The sensor element (40) of claim 1, wherein the sensor element (40) is a piezoelectric sensor element and the drive element (42) is a piezoelectric drive element.